UNIT : 8

NERVOUS SYSTEM

The system which controls, regulates and coordinates various body activities is known as nervous system.

Functions of Nervous System

1. It links and coordinates the activities of various systems and organs.
2. It stimulates or inhibits the function of glands, visceral organs etc.
3. The sensory organs like eye, ear, nose, tongue, and skin help to receive information from environment.
4. It helps to maintain steady state of body.

Types of Nervous System

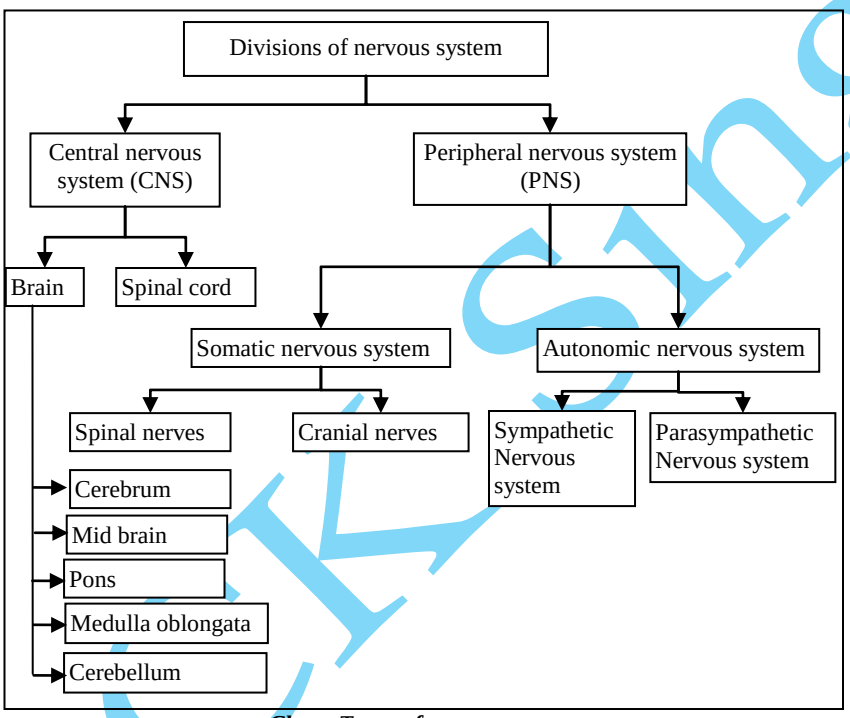


Chart. Types of nervous system

NEURON

The structural and functional unit of the nervous system is known as neuron. It is also known as nerve cell.

TYPES OF NEURONS

1. **Sensory or afferent neurons**: It carries the sensory impulses from different parts of the body to the central nervous system.
2. **Motor or efferent neurons**: It carries the motor impulses from central nervous system to the different parts of the body like muscles, glands, blood vessels etc.
3. **Mixed neurons:** It consists of both sensory and motor neurons outside the spinal cord.

STRUCTURE OF NEURON

The neuron is made up of three parts:

1. **Cell body:** It is also known as soma. The cell bodies of neurons form grey matter and nuclei in the central nervous system and ganglia in the peripheral nervous system.
2. **Dendrites:** Dendrites are the branched processes of the neuron, form the white matter of the nervous system. It is conductive in nature and transmits impulses towards the nerve cell body.
3. **Axon:** Axon is the longer process of the neuron. Most axon is surrounded by myelin sheath and neurilemma. The axons having a myelin sheath known as myelinated neuron and those without myelin sheath are known as non-myelinated neuron.

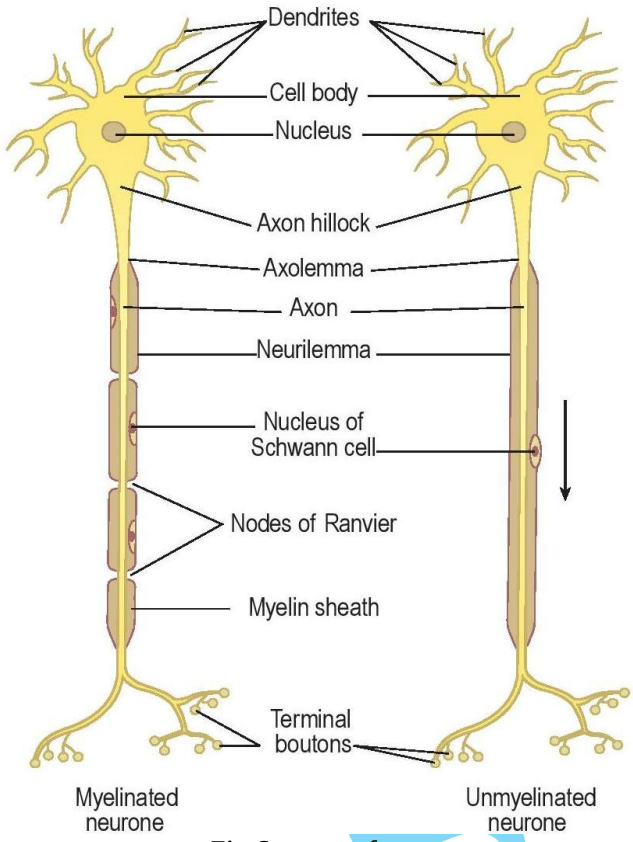


Fig. Structure of neuron

FUNCTIONS OF NEURON

1. It transmits signal to the brain and spinal cord.
2. It carries signals away from the brain and spinal cord
3. It connects different types of neural pathways to each others.

SYNAPSE

The junction between two neurons is known as synapse.

Types of Synapse

1. **Axosomatic synapse:** The axon of one neuron which terminates on cell body of another neuron is known as axosomatic synapse.
2. **Axodendritic synapse: -** The axon of one neuron which terminates on dendrite of another neuron is known as axodendritic synapse.
3. **Axoaxonic synapse: -** The axon of one neuron which terminates on axon of another neuron is known as axoaxonic synapse

Function of Synapse

- It transmits the impulses, i.e. action potential from one neuron to another neuron.

NEUROTRANSMITTERS

The chemical substance that acts as the mediator for the transmission of impulse from one neuron to another neuron through a synapse is known as neurotransmitters. Examples: acetylcholine (ach), dopamine, nor adrenaline, adrenaline, histamine, gamma amino butyric acid (GABA), serotonin etc.

REFLEX ACTION

Response to a peripheral nervous stimulation that occurs without our consciousness is known as reflex action. It is a type of protective mechanism and it protects the body from irreparable damages.

REFLEX ARC

The anatomical nervous pathway for a reflex action is known as reflex arc. A simple reflex arc includes five components.

a) Receptor
b) Sensory or afferent neuron

c) Centre
d) Motor or efferent neuron
e) Effector organ

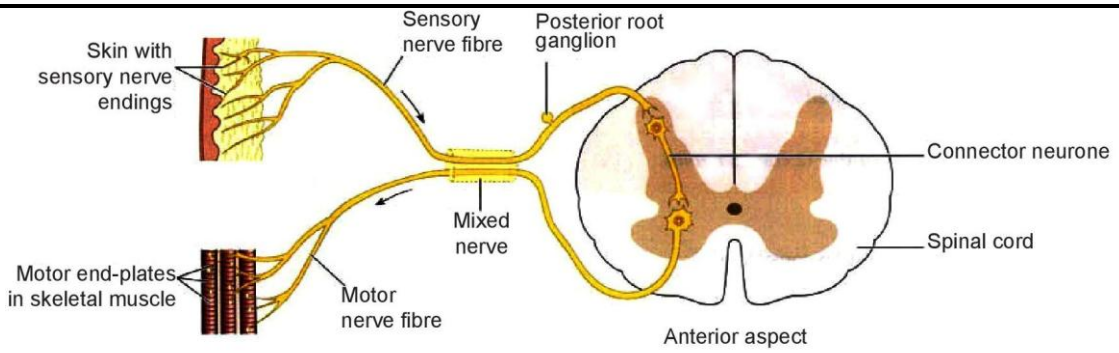


Fig. Reflex arc

CENTRAL NERVOUS SYSTEM

Central nervous system is the part of nervous system which consists of brain and spinal cord.

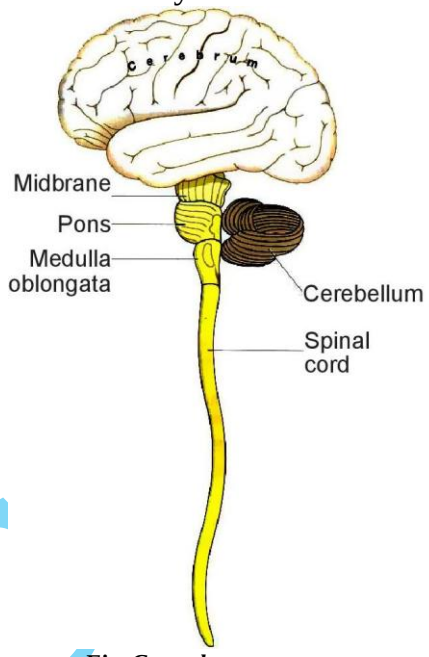


Fig. Central nervous system

BRAIN

Brain is the part of central nervous system. It lies in the cranial cavity. The average weight of brain is 1.5kg. The brain consists of the following parts:

- Cerebrum
- Mid brain
- Pons
- Medulla oblongata
- Cerebellum

} Brain stem

CEREBRUM

Cerebrum is the largest part of the brain which is made up of two cerebral hemispheres such as right cerebral hemisphere and left cerebral hemisphere. Both cerebral hemispheres are connected by thick band of nerve fibers called corpus callosum.Each hemisphere contains a cavity called the lateral ventricle. The cerebrum is divided into four lobes such as frontal lobe, parietal lobe, temporal lobe and occipital lobe by three fissures.

Functions of cerebrum

1. It controls all mental activities like thinking, memory, intelligence, reasoning, feeling, emotions, speech etc.
2. It analyzes sensory perception like pain, temperature, touch, hearing, taste and smell.

3. It controls voluntary muscle contraction.

HYPOTHALAMUS

Hypothalamus is the part of diencephalon (meaning between brains) and lies below the hypothalamic sulcus on the lateral wall of third ventricle. It link with the posterior lobe of the pituitary gland by nerves and to anterior lobe by a complex system of blood vessels.

Functions of Hypothalamus

1. It regulates body temperature
2. It produces releasing hormones
3. It regulates water balance
4. It regulates cardiovascular system
5. It regulates autonomic nervous system
6. It controls sexual functions
7. It regulates fat and carbohydrate metabolism
8. It controls appetite.

BRAIN STEM

i. Mid brain: Mid brain is the smallest part of brain. It lies between the cerebrum and pons varolii.It consists of nuclei and nerve fibers (tracts), which connect the cerebrum with lower part of the brain and with the spinal cord.

Functions of Mid brain

(a) It controls visual and auditory systems as well as eye movement.
(b) It controls body movement.

ii. Pons: Pons is the middle part of the brain stem. It is situated in the front of cerebellum, below the midbrain and above the medulla oblongata. It consists of nerve fibers (white matter) that forms bridge between the two hemispheres of the cerebellum. It is about 2.5 cm in length.

Functions of Pons

(a) It provides information to different parts of the nervous system like the cerebellum, cerebrum and spinal cord.
(b) It plays role in generating dreams.

iii. Medulla oblongata: The caudal part of brain stem is known as medulla oblongata. It extends from lower border of the pons and above the 1st cranial nerve where it is continuous with spinal cord. It is about 2.5cm long and lies within the cranium above the foramen magnum.

Functions of Medulla oblongata

The medulla contains four vital centers such as cardiovascular center, respiratory center, reflex centers, and vasomotor centre.

a. The cardiovascular center of medulla controls rate and force of cardiac contraction and also controls blood pressure.
b. The respiratory center of medulla controls rate and depth of respiration.
c. The reflex center of medulla causes vomiting, coughing, sneezing and swallowing.
d. The vasomotor centre of medulla controls diameter of blood vessels.

CEREBELLUM

The little part of brain is known as cerebellum. It lies behind the pons & medulla and below the cerebrum within posterior cranial fossa. The outer surface of cerebellum consists of grey matter and inner surface consists of white matter. The cerebellum is connected to the brain stem by bundle of nerve fibers known as cerebellar peduncles.

Functions of Cerebellum

1. It co-ordinates the muscular body movement.
2. It maintains tone, posture, and equilibrium.
3. It controls reflex action of the skeletal muscles activities.
4. It receives information from ears and controls voluntary movements.

SPINAL CORD

The spinal cord is elongated, cylindrical and lower part of the central nervous system. It is continuous above with the medulla oblongata and extends from the foramen magnum in occipital bone to the lower border of the 1st lumbar vertebra. It is about 45 cm long in adult males and 40 cm in adult females.

Structure of Spinal cord

1. **Parts of spinal cord**

   The spinal cord is divided into two parts:

   i. **Grey matter:** The inner part of the spinal cord is known as grey matter. It is seen in "H" shaped structure, having two posterior, two anterior and two lateral columns.

   ii. **White matter:** The periphery area of the spinal cord is known as white matter. It consists of bundle of both myelinated and nonmyelinated nerve fibers. The white matter of the spinal cord is arranged in three columns or tract such as anterior, posterior and lateral tract.

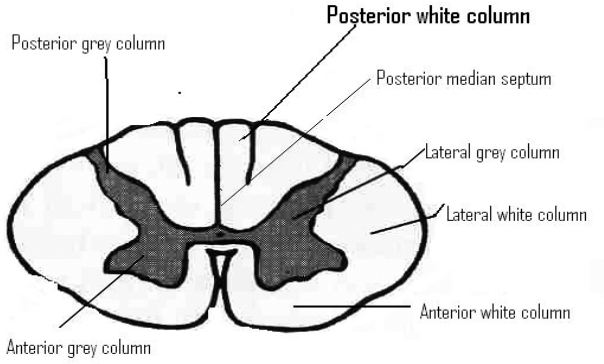
2. **Tracts of Spinal Cord**

i. Ascending tract

- Anterior spinothalamic tract
- Lateral spinothalamic tract
- Ventral spinocerebellar tract
- Dorsal spinocerebellar tract

ii. Descending tract

- Anterior vestibulospinal tract
- Lateral vestibulospinal tract
- Reticulospinal tract
- Tectospinal tract



Functions of Spinal cord

1. It is the main pathway of all incoming and outgoing impulses from the higher centre to the periphery & vice versa.
2. It is the main centre of reflex activities.

MENINGES

The meninges are connective tissue membrane, covering the brain and spinal cord. It lies between the skull and the brain, between vertebrae and spinal cord. The meninges have three layers:

- Dura mater(Outer)
- Arachnoid mater(Middle)
- Pia mater(Inner)

The dura mater and arachnoid mater are separated by a space called subdural space. The arachnoid mater and pia mater are separated by the subarachnoid space containing cerebrospinal fluid.

Functions of Meninges

1. It protects the brain and the spinal cord.
2. It prevents movement of the brain.
3. It provides support to the spinal cord.

CEREBRO SPINAL FLUID (C.S.F)

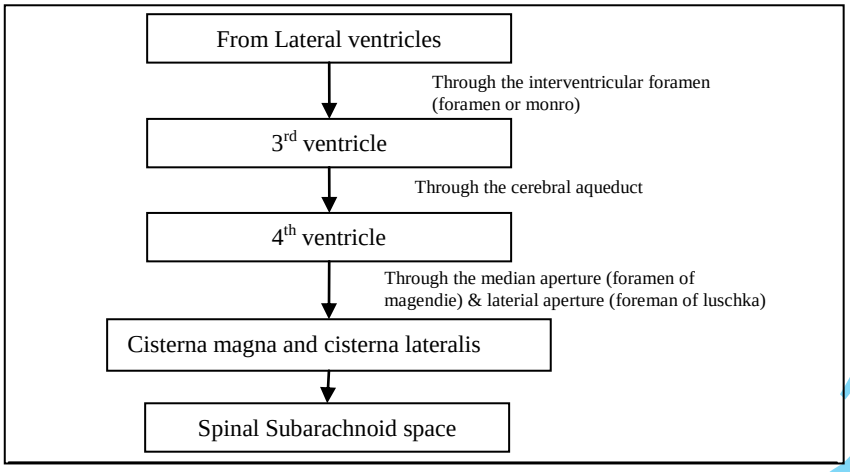
Cerebrospinal fluid is a colourless, transparent, clear modified tissue fluid. It contains in the ventricular system of the brain and in the subarachnoid space around the brain and spinal cord.

Formation of C.S.F

The cerebrospinal fluid is formed by the lateral ventricles and lesser amounts of the 3rd and 4th ventricles.

- Rate of formation-0.5ml/minute.
- Volume -150ml.

Circulation of C.S.F



Absorption of C.S.F

The CSF is absorbed chiefly through the arachnoids villi and granulation. It is also absorbed by veins related to the spinal nerves.

Composition of C.S.F

The CSF is made up of:

- **Water** - 99.13%
- **Solids** - 0.87%:

The solid substance of CSF is made up of protein, amino acids, sugar, cholesterol, urea and uric acid.

Functions of C.S.F

1. It supports and protects the brain and the spinal cord.
2. It maintains uniform pressure around the brain and the spinal cord.
3. It keeps the brain and the spinal cord moist.
4. It acts as a cushion and shock absorber between the brain and the cranial bones.
5. The nutritive substances and waste materials are interchange into CSF and blood.

PERIPHERAL NERVOUS SYSTEM

Peripheral nervous system is the part of nervous system which consists of all the nerves outside the brain and the spinal cord.

Types of Peripheral Nervous System

The peripheral nervous system is divided into two parts:

1. Somatic nervous system
2. Autonomic nervous system

1. Somatic Nervous System: Somatic nervous system is a part of peripheral nervous system includes the nerves supplying the skeletal muscles (voluntary controls). It controls movement of the body by acting on the skeletal muscles. The somatic nervous system consists of two types of nerves and they are:

- Cranial nerves
- Spinal nerves

i. Cranial Nerves: There are twelve (12) pairs of nerves originating from nuclei in the inferior surface of the brain and they are:

No.	Name	Type	Functions
I	Olfactory	Sensory	Smell.
II	Optic	Sensory	Vision, visual information.
III	Oculomotor	Motor	Eye movement, pupil constriction. (Moving the eye ball medially, upward and downward).
IV	Trochlear	Motor	Eye movement (Moving the eye ball downward and outward).
V	Trigeminal	Mixed	Sensation for the face, motor to muscles of chewing.
VI	Abducent	Motor	Eye movement (Moving eye ball laterally).

VII	Facial	Mixed	Taste sensation, facial expression, secretion of tear and saliva.
VIII	Vestibulocochlear	Sensory	Hearing, balance.
IX	Glossopharyngeal	Mixed	Sense of taste, pharynx movement, secretion of saliva.
X	Vagus	Mixed	Heart, lungs, GIT, ear.
XI	Accessory	Motor	Movement of neck, shoulder.
XII	Hypoglossal	Motor	Tongue movement.

ii. Spinal Nerves: The nerves arising from the spinal cord are called spinal nerves. There are thirty one (31) pairs of nerves. These nerves arise from the side of the spinal cord by passing through the intervertebral foramina formed by adjacent vertebra and they are:

- Cervical - 8 pairs (In neck region)
- Thoracic – 12 pairs (In thorax region)
- Lumbar - 5 pairs (Upper abdomen region)
- Sacral – 5 pairs (Lower abdomen region)
- Coccygeal – 1 pair (In tail region)

The spinal nerves are mixed nerve. They carry both sensory (afferent) and motor (efferent) impulses.

2. Autonomic Nervous System: The system which controls and co-ordinates various function of the body "automatically" (independently) are called autonomic nervous system. It "automatically" controls the rate of heart beat, movement of the alimentary canal etc. It is also known as visceral nervous system because it innervates the visceral organs. The activity of autonomic nervous system is controlled by medulla oblongata and hypothalamus. The autonomic nervous system is divided into two antagonistic divisions.

i. Sympathetic Nervous System: It is also known as thoracolumbar outflow because it arises from the thoracic and lumbar region of the spinal cord (T_1-L_2).

ii. Parasympathetic Nervous System: It is also known as craniosacral outflow because it arises from the brain and sacral region of the spinal cord.

DIFFERENCE BETWEEN SYMPATHETIC AND PARASYMPATHETIC NERVOUS SYSTEM

Effectors organs	Sympathetic effects	Parasympathetic effects
Eye Ciliary muscle pupil	 Relaxation Dilation	 Contraction Constriction
Lacrimal glands (Tear)	Decrease in secretion	Increase in secretion
Salivary secretion (Saliva)	Decrease in secretion and vasoconstriction	Increase in secretion and vasodilation
Gall bladder	Relaxation	Contraction
Urinary bladder	Constriction of internal sphincter	Relaxation of internal sphincter
Sweat glands (Sweat)	Increase in secretion	
Heart	Increase Rate and force of heart	Decrease Rate and force of heart
Blood vessels	Constriction of all blood vessels except those in heart and skeletal muscle	Dilation
Bronchioles	Dilation	Constriction